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Lake Mead:
Threats and Benefits of the Largest Reservoir in the United States

A Senior Project

presented to

the Faculty of the Social Sciences

California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Social Science; Bachelor of Science

by

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June, 2010

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Research Proposal

Fresh water around the globe is becoming more of a luxury as each day passes. The world population is exploding at an alarming rate, environmental disasters, and countries allowing certain corporations to privatize drinking water all make water more of a luxury. Because of this, I believe the next world crises will be over water, not oil, specifically: availability, access, and fresh water rights.

The American Southwest is currently in one of the worst droughts since humans started keeping track of weather in the region. Because of this, the Colorado River and the manmade reservoirs along it have changed a lot since their conception in the early 1930's with the construction of Hoover Dam. Because of the extended drought in the Southwest, Lake Mead is a relevant topic that should be explored in detail, specifically the problems and benefits of the reservoir that borders Southern Nevada and Northwest Arizona.

My senior project will be mainly a "Library Research Paper" because I will be relying on published articles, books, online databases, etc. My paper will explore the history of the Colorado River, the history of Hoover Dam, studies of fish, Zebra and Quagga Mussels, drought conditions, revenue, etc. of Lake Mead from 1936 to the present. Some areas I would like to possibly explore are the Zebra Muscles that have made their way into the lake. How does this effect the environment in and around the lake, where did they originate, what can be done about them, and what is being done currently? Another area I would like to explore would be the quality of water that is in the lake. Are there high pharmaceutical levels in the lake? If so, how are these affecting the wildlife and are they detrimental to humans? Are there grants in affect to improve the

water quality in the lake? How are the lower water levels (the lake is currently 44% full) effecting recreation in the area and what are the marinas on the lake doing to cope with the lower water levels? I'd like to also include in my research paper where the water goes, its uses', the politics, what is in store for the lake and region in the future as growing demands for water and climate change increase.

In the context of the research paper will have chapters that address each topic, thus keeping organization a high priority of the paper. The paper will be organized in chronological order including; history of the region, why Hoover Dam was built, history of the dam and lake, dangers and benefits of the lake, and then finally exploring the future of the lake and region.

Annotated Bibliography

"Hoover Dam." *Columbia Electronic Encyclopedia, 6th Edition*, (2009): 1. Columbia Electronic Encyclopedia gives a lot of technical details on Hoover Dam. The article deals mainly with when the dam was built, the specs of the dam, who Lake Mead supplies water to along with the amount of water, and who receives electricity. This will be important in my research paper because the technical details will add for basic intro material.

"Mead, Lake." *Columbia Electronic Encyclopedia, 6th Edition*, (2009): 1. Columbia Electronic Encyclopedia gives a lot of technical details on Hoover Dam and Lake Mead. The article deals mainly with the specifications of the lake, how large the lake is, how much shoreline, and how deep the lake is. This will be important in my research paper because the technical details will add for basic intro material to my paper.

"New Water Intake at Lake Mead Will Keep Las Vegas Wet." *ENR: Engineering News-Record*, 260.11 (2008): 13. This article goes more in depth than Michael Milstein's "Remedies on Tap" as it provides technical details. These will be good in my paper so the reader has a better understanding on what is going on.

Mark, Jason. "Climate Change Threatens to Dry Up the Southwest's Future." *Earth Island Journal*, 23.3 (2008): 34-40. Jason Mark explores the problems with Lake Mead and the water rights compact signed in the 1920's allocating certain percentages of water to each state and Mexico. The article discusses agriculture and how most of the water leaving the lower Colorado ends up on farm land, not to Las Vegas even though 90% of Las Vegas gets its water from Lake Mead. This article will be vital in the threats portion of my paper.

Milstein, Michael. "Remedies on Tap." *Popular Mechanics*, 185.11 (2008): 16. Michael Milstein explores the possible answer to Lake Mead's low water levels. A company in Germany is building a special cutting tool so addition pipeline can be laid deeper into Lake Mead. This is needed to be done because Hoover Dam's two water towers don't go deep enough currently and can be sucking up only air in the near future. This will provide my paper with information on what the Southwest is doing to combat drought conditions.

National Park Service. U.S. Department of the Interior. *Live Zebra Mussels Found at Lake Mead; Resource Agencies Initiate Program to Assess Extent and Prevent Spread*. 10 Jan. 2007. Web. 18 Apr. 2010. <http://home.nps.gov/applications/release/print.cfm?id=719>. The long battle to keep the Zebra Mussel out of Lake Mead has been lost. The press release addresses the steps to clean your boat before putting your vessel in Lake Mead. This will be helpful in explaining the Zebra Mussel problem in my paper.

"Boulder City History." *Boulder City History*. Public Broadcasting Service. BCNV.org. Web. 18 Apr. 2010. <http://www.bcnv.org/History.asp>. Boulder City was built to house the workers who were building Lake Mead. PBS goes into detail about city planning,

living conditions, and what made Boulder City, Boulder City. This will provide needed historical information for the paper, for without the city, Hoover Dam could not be built, and thus Lake Mead could not be formed.

Stokstad, Erik. "Feared Quagga Mussel Turns Up in Western United States." *Science*, 315.5811 (2007): 453. The Quagga Muscle has been found in Lake Mead after a long battle to prevent the spread of the muscle from the Great Lakes. The article talks about the problems that have occurred since the muscle has been found and what lies ahead for the cleanup efforts. This is just another threat I plan exploring in my paper.

United States. U.S. Geological Survey. *Organic Chemical Concentrations and Reproductive Biomarkers in Common Carp (Cyprinus Carpio) Collected from Two Areas in Lake Mead, Nevada, May 1999–May 2000*. By Steven Goodbred, Thomas Leiker, Reynaldo Patiño, Jill Jenkins, Nancy Denslow, Erik Orsak, and Michael Rosen. USGS, 23 Aug. 2007. Web. 18 Apr. 2010. <http://pubs.usgs.gov/ds/2007/286/>. This publication explores the chemicals found in carp from three locations in Lake Mead and talks about the risks if changes aren't made. This will be included in my threats chapter of my paper.

Walsh, Bryan, Jyoti Thottam, Madhur Singh, and Daniel Williams. "Dying for a Drink." *Time*, 172.24 (2008): 46-49. The authors explore the effects of droughts and global warming around the world. One of their stops is the Southwest, mainly Lake Mead and Las Vegas, and the drought problem that has began in 2000. The article presents Las Vegas' water usage numbers, what is currently done to combat the issue, and what can be expected to happen in the near future. Since my paper focuses on both the threats and benefits of Hoover Dam and Lake Mead, this article will provide excellent information for both.

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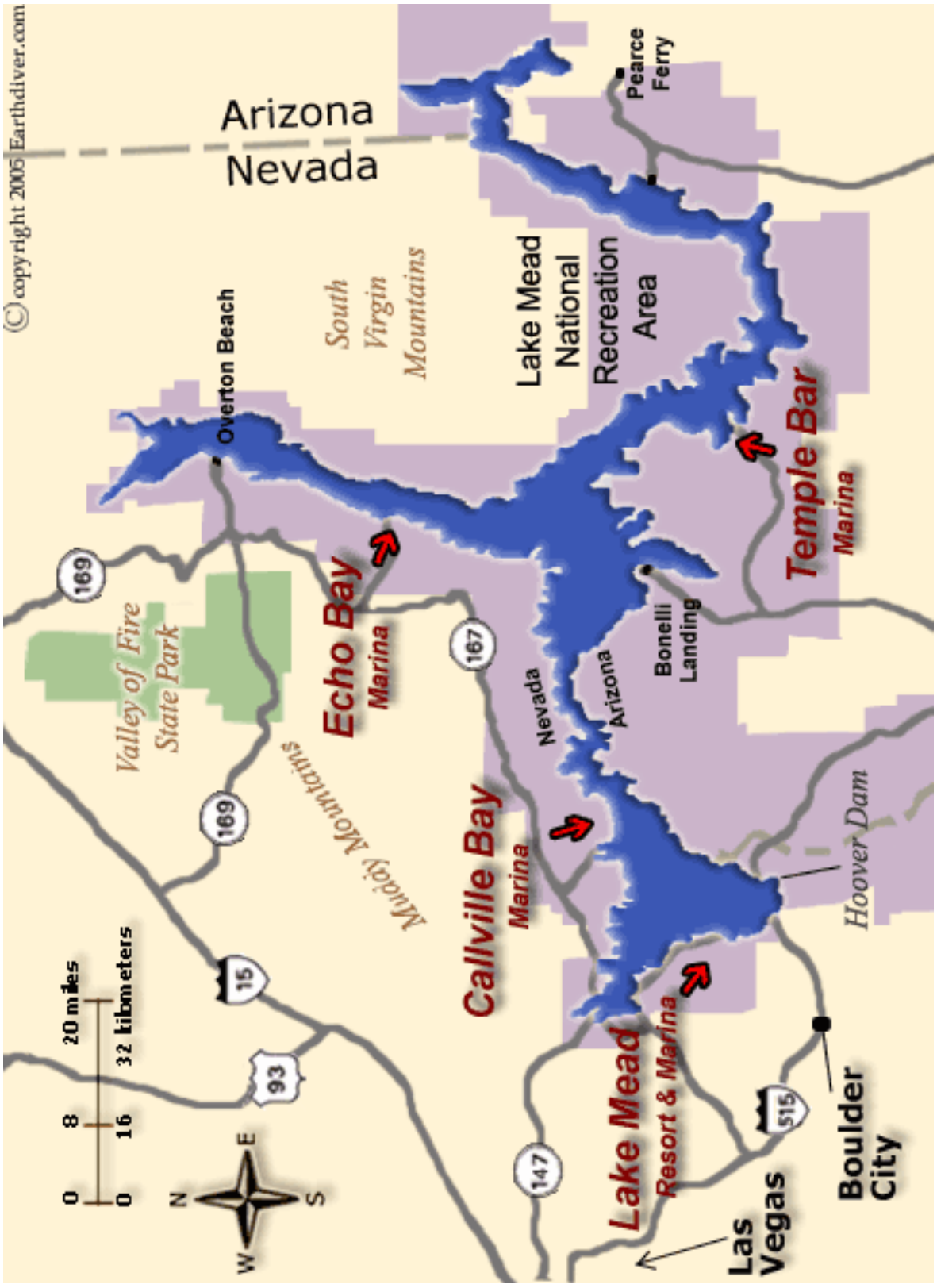

Figure 2: Courtesy of *HouseBoating.org*
(http://www.houseboating.org)

Introduction

The Colorado River, better known as the Colorado, has a long history dating back over seventeen million years; helping form what we know today as the Grand Canyon (Wilford). While the Colorado has a long history dating back millions of years, the last eighty-eight years have seen the most human induced change. Starting with the signing of the Colorado River Compact in November 1922, the Boulder Dam (also known as the Hoover Dam) was completed in 1936, which resulted in the filling of Lake Mead in 1937. The Colorado was seen as uncontrollable, with its frequent flooding of the lower Southwest that wipe out towns and farmland. The construction of Hoover Dam, between 1931 and 1936 has also had major environmental implications along both sides of the river. While we were able to tame the mighty Colorado and stop Mother Nature's floods, we face new environmental challenges today as Mother Nature once again threatens the Southwest in new ways never anticipated until now.

The Southwest involving mainly California, Arizona, and Nevada, are in a severe crisis that daily goes unnoticed. The current Southwestern drought started at the turn of the century and is predicted by multiple computer models to last upwards of multiple-decades (Mark). The drought would cause the reservoirs along the Colorado River to deplete further. The Colorado River Compact signed on November 24, 1922, split the Colorado into two parts, the upper basin that consisted of Colorado, Utah, Wyoming, and New Mexico, and the lower basin that consists of California, Nevada, and Arizona (Stevens). In doing so, the Colorado River Compact allocated a certain amount of water to each state annually. The major problem that could not have been forecasted in 1922 was the high flow of the Colorado River during the time the allocation process took

place. In the last few decades, the flow of the Colorado has dropped significantly putting major strain and stress on both Lake Powell and Lake Mead.

Lake Mead is the lifeblood of the Southwest when talking about irrigation, electricity, and recreation. This paper will not be able to stress enough the threats the lake and the Southwest have experienced in the last decade. The Federal Government, state agencies, and cities that benefit from Lake Mead will need to take drastic measures in the next ten years to assure the lake and region remain beneficial to the Southwest. The Scripps Institute of Oceanography has predicted a fifty-percent chance Lake Mead will go dry by 2021 if weather and water usage remain as predicted (Mark). Lake Mead is the main focus of this paper that will highlight the history of the area, the threats and the benefits the lake has provided.

Chapter I – Background

Lake Mead was not built overnight. Many obstacles had to be overcome before Hoover Dam could restrict the mighty Colorado River. During the building of Hoover Dam technological advancements along with trial and error took place on the floor of Black Canyon. A project so great had never been attempted before. The formation of the water rights in the early 1920's led to the allocation of the Colorado River to the seven states in the drainage basin. The difficulties and disagreements the seven states had allocating the water and building Hoover Dam would be a tell-tale sign the overall project would have its share of setbacks. Beyond the Black Canyon and concrete that would eventually find its final resting place there, Boulder City, Nevada, would begin to spring up just a few miles away. The conditions families faced before, during, and after the town

was built are hard to imagine. The sweltering 110+ degree Fahrenheit days and freezing winter nights made life unbearable. This paper is neither about Boulder City nor Hoover Dam, however it is impossible not to talk about them when exploring Lake Mead. The three go hand-in-hand when explaining the history of the lake. Without the city or dam, Lake Mead would not exist.

Dividing Up the Colorado River – Water Rights

When talking about the Southwest and water rights in the same sentence, people with knowledge regarding the Colorado River and how the water is allocated to Southwestern states will most likely tell you how broken the system is, and with good reason. Hoover Dam and Lake Mead have had problems regarding water rights since before the building of the dam, but the last decade has pushed these somewhat small problems into a present day crisis.

The Colorado River Compact was signed on November 24, 1922, at the request of Herbert Hoover, who was then the United States Secretary of Commerce (Stevens). January 1922 would prove to be the actual start of the water rights movement and the later building of the Hoover Dam. Herbert Hoover met with the state governors involved in the distribution of water from the Colorado River to negotiate rights. In all, seven states would be involved: Wyoming, Utah, Colorado, New Mexico, Nevada, Arizona, and California. The Federal Government could not determine exactly how much water to allocate to each state as each state could not agree on a fixed amount. Herbert Hoover personally stepped in and proposed a plan to divide the Colorado River into two basins: the upper and lower basin. This proved to help with negotiations between states. Each

basin was allocated seven and half million acre-feet (equivalent to 325,851 gallons) of water annually. The lower basin is allowed to take an extra one million acre-feet of water as needed. The last two million acre-feet would be left as reserves with enough water to be allocated to Mexico if ever needed. Mexico would not use these reserves for another forty years after a treaty was signed. The division of the Colorado River's water among the upper and lower basins assumed the annual Colorado River flow would be eighteen million acre-feet annually (Stevens). This has proven to be devastating to water allocation to the upper and lower basins during the past decade because more water has been allocated then there is actually water. In recent years, the annual flow of the Colorado River has dropped off significantly.

Once the Colorado River Compact was signed by each state in 1922, the compact was ratified by each state government with the exception of Arizona. Arizona was only state that disagreed with the compact on accounts that it felt California would take the majority of the water. However, the agreement only required the ratification from six of the seven states in order to become binding (Stevens). Arizona in conjunction with government officials and several powerful individuals would later put up a fight against the Boulder Canyon Project opposing the construction of the Hoover Dam.

The main issues concerning the Boulder Canyon Project proposal were raised by people in the Federal Government out east and Arizona. Lawmakers in Washington D.C. believed that the construction of the Dam was too costly for the Federal Government at the time. This could not have been farther from the truth as the project would be repaid with interest by 1987 (Desert USA). Many powerful people also opposed the construction of Hoover Dam, mainly Harry Chandler, publisher of the Los Angeles

Times. His main concern would not be financial matters or the construction risks of building the project, but rather his 830,000 acres in Mexico, just south of the Imperial Valley (Stevens). Within the Boulder Canyon Project proposal was a proposed canal that would bring water from the Colorado River to the Los Angeles basin. This proposal would later be known as the All-American Canal. Chandler figured if the canal was built, less water would make it to his fields just south of the border and therefore starve his fields of much needed water (Stevens). Chandler would team up with lawmakers in Arizona who also opposed the project. These lawmakers in Arizona figured the All-American Canal would divert water from their state, ruining their economy and growth potential (Stevens). Along with Harry Chandler and the state of Arizona, other lawmakers saw the construction of Hoover Dam as a threat to the electric business, forcing the Federal Government in direct competition with private electric companies in the Southwest (Stevens).

The Boulder Canyon Project bill passed the House of Representatives easily in May of 1928. The Senate viewed and passed the bill in December of 1928. A week after the bill passed the Senate; President Coolidge signed the bill into law. In doing so, the Boulder Canyon Project Act set aside $165 million for the construction of Hoover Dam and the All-American Canal (Stevens).

Before either the Hoover Dam or the All-American Canal were set to be built, many tensions within the Federal Government existed. Some lawmakers in the East saw the project as a waste of the Federal Treasuries money while most lawmakers out West saw the need for the project. As we explore issues faced by the Colorado River and the water rights surrounding it, even today the seven states that receive water from the

Colorado River are having issues with the water rights much like back in the 1920's. Water rights issues today are actually more severe than in the late 1920's because more people today rely on the Colorado River system.

Town in the Middle of Nowhere – Boulder City, Nevada

Boulder City, Nevada, is located south of Hemenway Bay, which is located on the shore of Lake Mead. The town is twenty-five miles outside of Las Vegas, and only eight miles from Hoover Dam. The construction of Boulder City began in August of 1930 when workers for the Hoover Dam project could not find adequate housing nearby (BCNV). Since people were in desperate need of work and housing, many Americans moved west when news of the Hoover Dam project spread across the United States. Some workers would leave Las Vegas to find work at Black Canyon. Many Americans did not have a plan when they arrived, nor did they realize the weather conditions they were about to face.

Having been a frequent visitor to Lake Mead and Hoover Dam, I can testify firsthand the area gets extremely hot. A typical summer day can be 100+ degrees Fahrenheit. No matter how much water one drinks the thirst is constant. The workers who arrived before the construction of Boulder City formed what would be called Ragtown; small housing dwellings that consisted of rags, wood, or whatever else they could find (BCNV). The Bureau of Reclamation was in charge of building and running Boulder City, and they turned to well known architect Saco DeBoer to design the city plan. Because the Great Depression was at its height, DeBoer had to design a simple city plan (BCNV). Elwood Mead who the lake was later named after, "Bureau of

Reclamation Commissioner…withdrew lands from public access for the project" of building Boulder City (PBS). Essentially Elwood Mead set aside land for the formation of Boulder City.

Boulder City did not have an education system, as the Federal Government did not plan for workers who moved west to bring their families, but Six Companies, Inc. would donate enough money to build crude schools (PBS). The health care at Boulder City was almost nonexistent. The closest hospital was in Las Vegas, which was out of reach for many. Six Companies later built a hospital within Boulder City in 1932, but only the workers of Hoover Dam could get care there (PBS). Their families would have to make the twenty-five mile trek to Las Vegas to get health care.

While the Hoover Dam project did hire a few none white people, they were not allowed to live inside Boulder City as it was reserved for whites only. These minorities would face the same harsh realities of hot summers and cold winters as the others. Sims Ely would become known as the legal system of Boulder City; whatever he said went. Because so many workers were happy to have a job and a house provided by the Federal Government, many historians believe Boulder City in the early 1930's was the safest city in the United States (BCNV). If a worker got in legal trouble, Ely had the right to fire the worker, who then had to leave Boulder City since the town was reserved for workers and their families only (BCNV).

Life for the typical worker and family involved in the Hoover Dam Project would present of numerous challenges in the desert. There was no air conditioning and little shade at the work sites or in the town. The location of Hoover Dam proved to be extremely hard on the people that worked around the area as a few died from the

elements. Unfortunately there is insufficient amount of data on what the people faced during the winter months. However winters in the Las Vegas Valley and Boulder City can be extremely cold, often times sub-freezing. With this in mind, it is easy to think that the winter months were just as harsh as the summer months for the people working on Hoover Dam along with the families living in Boulder City.

A Project of Mega Proportions – Hoover Dam

Hoover Dam is one of the most famous dams in the United States, not because of its size or location, but because of the time period in which it was built. The dam is considered an icon for the fact that many Americans saw it as uplifting – being able to build such a structure during an economic disaster – the Great Depression. Hoover Dam would become the largest concrete structure and largest hydroelectric generating station in the world when it was completed in 1936. It would hold this title until 1948 (USBR). The Boulder Canyon Project would employ 21,000 workers between 1931 and 1936 with an average of 3,500 workers working on the project daily (USBR). This is significant because in 1931 unemployment in the United States was in the double digits, which made finding work for many nearly impossible. When legislation was passed in 1928 allowing the Boulder Canyon Project to move forward, thousands of people moved out west in hopes of finding work building the dam. Few people in the Southwest at the time also moved to Boulder City to hopefully find work on the dam.

The dam was originally planned to be built eight miles north of its current location in Boulder Canyon. Further research showed that if the dam was constructed in this location flooding below the dam by the Colorado River was still possible in the

Boulder Basin. Getting workers to Black Canyon would also prove to be a difficult feat. The project was moved to Black Canyon, but the Boulder Canyon Project name and the later naming of Boulder Dam (known as Hoover Dam since 1947) stuck (Stevens).

The Boulder Canyon Project was awarded to Six Companies, Inc., which was a collaboration of six construction firms that merged in hopes of winning the contract. They submitted the lowest competitive offer and won the Boulder Canyon Project with a bid of $48,890,955. The Chief Executive officer would be Frank Crowe (Arizona Leisure). Frank Crowe ran a tight ship on the overall project making labor work around the clock, seven days a week. When writing the Boulder Canyon Project, the Federal Government included incentives to complete the project promptly or prior to the due date of seven years. On the other hand, if the project was not completed within seven years, Six Companies, Inc. would be fined for every day the project went over the dead line (Arizona Leisure). The project would be completed almost two years ahead of schedule, a construction feat that is still amazing to this day (Arizona Leisure). Because the project was completed so early, Frank Crowe was awarded a $350,000 bonus (PBS).

Hoover Dam over came major obstacles during construction. The main obstacle was how to pour the thousands of barrels of concrete into the river canyon and allow it to dry. Pouring the concrete as one piece was impossible because the concrete would not be able to dry. The system devised by Frank Crowe and other engineers called for concrete to be poured in block sections. This operation would go on for two years, twenty-four hours a day, seven days a week (PBS). The hot, desert environment caused the concrete to run the risk of cracking as it could have dried too quickly. Metal pipes were inserted in the concrete to keep the concrete cool while it dried (USBR). The dam is a total of

726.4 feet tall and weighs more than 6,600,000 tons (USBR). The dam contains a vast amount of concrete as "there are 4,360,000 cubic yards of concrete in the dam, powerplant and appurtenant works. This much concrete would build a monument 100 feet square and 2-1/2 miles high; would rise higher than the 1,250-foot-tall Empire State Building if placed on an ordinary city block; or would pave a standard highway 16 feet wide, from San Francisco to New York City" (USBR).

Hoover Dam was an image of hope for a lot of people out of work during a dark time in United States History. The dam today is still visited by a lot of tourists from all over the world and dam tours are offered daily.

Chapter II -- Threats to Lake Mead

Lake Mead has been around for roughly seventy-three years. In that relatively short time the lake has had its share of history. With the completion of Hoover Dam, the Colorado River would be blocked behind the dam starting in 1937 to form Lake Mead. Lake Mead is the largest reservoir in the United States with 550 miles of shoreline, 115 miles in length, and has a maximum depth of 589 feet (Columbia). Lake Mead has allowed cities such as Las Vegas, Phoenix, and Tucson to grow exponentially since the late 1930's. Lake Mead is relied on by thousands and thousands of people daily given the geographical location of the lake and its sheer size. Nevertheless, with Lake Mead's location and sheer size come threats.

I have been visiting the lake annually since 1995, and within that time I have witnessed many changes to the lake and its surrounding environment. In this section I talk about the core threats the lake has faced in the past decade and will continue to face

unless substantive measures are undertaken to reverse the negative effects they have caused. The main threats include the water quality issues involving chemical pollutants, the invasion of the Zebra and Quagga Mussel, and the drought that has been affecting the lake since 2000.

What's in the Water – Study of Common Carp (Cyprinus carpio) at Lake Mead

The Colorado River, predominantly Lake Mead, provides drinking water to over 1.6 million Las Vegas residents (roughly 90% of the total population). On top of that, Lake Mead provides most of the drinking water for the casinos and hotels found in the Las Vegas, which have roughly thirty-five million tourists annually (Rosen). Given these statistics and how many people use the water annually, it is no surprise agencies are in place to ensure the water at Lake Mead meets regulations the agencies have emplaced.

Research on the Common Carp (Cyprinus carpio), one of the many fish found in Lake Mead, has proven to be one of the best ways to analyze the affects the water has had on wildlife and the human population. The United States Geological Survey conducted the main study between May 1999 and May 2000. It is interesting to note that during this time, Lake Mead contained the second highest water level in its history; the only other time the lake reached higher levels was in 1983. A follow up study was conducted in March of 2006 to determine whether the findings between May 1999 and May 2000 were skewed given the high water levels of Lake Mead. From May of 2000 to March of 2006, the water at Lake Mead had dropped almost sixty-five feet (Figure 2).

The primary study conducted between May of 1999 and May of 2000 addressed key locations for storm runoff into the lake, mainly Las Vegas Bay (west region). These

findings would be compared to another site, Overton Arm (north region). This area of the lake catches runoff from Muddy River and the Virgin River and is not known to have high levels of waste runoff. Las Vegas Bay is the closest bay to Henderson and Las Vegas, Nevada, and thus tends to have higher waste runoff from the Las Vegas Wash via treatment facilities and storm runoff. It also receives runoff originating from ground water in the Las Vegas Valley (Goodbred abstract).

The study would last twelve months, catching and recording Common Carp at each location. At the end of the study in May of 2000, the findings would be compared from each location to reveal startling finds. The findings confirmed high levels of "…synthetic organic compounds (SOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated pesticides, and pharmaceuticals and personal care products" at Las Vegas Bay (Rosen). The USGS study highlighted "…Sixteen of the 33 compounds detected in male common carp from Las Vegas Bay and 10 compounds detected in males from Overton Arm have the potential to disrupt the endocrine system in fish in Lake Mead" (Goodbred abstract). Furthermore, "…during May and June 1999, the mean concentration of all organic compounds detected in male common carp was 670 micrograms per kilogram from Las Vegas Bay and 109 micrograms per kilogram from Overton Arm" (Goodbred abstract). The levels at Las Vegas Bay, which is known to have higher wastewater and storm runoff from Henderson and Las Vegas, had levels six times higher than that of Overton Arm (Goodbred abstract).

The USGS has been conducting a similar test since 2006. With the water level dropping at an alarming rate, the USGS wants to see if the synthetic organic compounds found within Lake Mead have risen since the last study ended in May of 2000. The main

question the USGS asked in their recent study was: does lower water levels at Lake Mead increase the exposure of the Common Carp to synthetic organic compounds? The study is ongoing and should continue through 2010, but the general consensus the USGS has reached is that the lower water levels have exposed the Common Carp to higher concentrations of synthetic organic compounds found within the waters of Lake Mead.

So what does this scientific data mean? Simply put, as the water level at Lake Mead continues to drop the water quality continues to become worse and worse. Water quality at Lake Mead is critical because so many people and wildlife in the Southwest rely on the reservoir. Tougher regulations on wastewater runoff into the Las Vegas Wash need to be enacted, especially since the water level at Lake Mead is at the lowest it has been since the late 1930's. As the water levels continue to decrease over the next few years, current predictions expect over a fifteen-foot drop between 2010 and 2011, agencies increase the monitoring of what ends up in Las Vegas Wash. If they do not, this will have a negative effect on Lake Mead because it will further degrade water quality. Since the lake formed, agencies have been pretty relaxed on wastewater runoff that ends up in Las Vegas Bay, but with the current drought, and with water levels at the crisis point, agencies will need to use their power and force cleaner runoff into Las Vegas Bay. Failure to do so could hurt the large recreation industry at Lake Mead and cause health problems for the population of Las Vegas.

The invasion has begun – Zebra and Quagga mussels found in Lake Mead

The Quagga (*Dreissena rostriformis bugensis)* and Zebra mussels (*Dreissena polymorpha)* are native to Europe, and are indigenous to Ukraine and to parts of

southeast Russia. The mussels were first introduced to the Great Lakes by large shipping vessels when their large ballast tanks were infected with the mussels. Since the invasion to North America, agencies around the country have been scrambling to keep the mussels at bay, and trying to slow down the spread. The mussels are fast reproducers, and once they are introduced to a new environment it is almost impossible to get rid of them (Stokstad p.453).

Lake Mead is a major ecosystem for the Southwest. Wildlife and humans have utilized the lake since 1937 and just like any ecosystem; it is a fine balance to keep it self-sustaining. Lake Mead is facing a major crisis; the famous Quagga mussel and Zebra mussel are making their way west into its water. So what right? Just ask environmental agencies in and around the Great Lakes how the Quagga mussel has changed the Great Lakes ecosystem. The mussels find their way into pipes, drains, aqueducts, boats, etc. and wreak havoc causing companies millions of dollars to remove the mussels (Stokstad). The mussels filter fresh water, thus removing phytoplankton and nutrients fish need to survive (Stokstad p.453). This has cost the fishing industry millions of dollars.

Agencies out west knew this was a problem twelve years ago, when in 1998 they started the 100th Meridian Initiative, which was a joint effort between local, county, regional, and federal agencies to stop the spread of both the Quagga and Zebra mussels in lakes and river ways west of the Mississippi River. During this time the famous slogan, "Don't move a mussel" was created. Signs went up and booklets were given out at major marinas and rivers to help stop the spread of the mussel to waterways via boats and watercraft.

A major concern right after the 100th Meridian Initiative was created in 1998 is the Colorado River and the major reservoirs found on it (Lake Powell, Lake Mead, Lake Mohave, and Lake Havasu). The Colorado River and the reservoirs found along it are a major destination for boaters all over the United States. This puts Lake Mead at a high risk of being invaded by the Zebra and Quagga mussels because of the out of state boaters. The majority of which come from boaters out east where Zebra and Quagga mussels are widespread, potentially transporting the mussels via their boats to Lake Mead without even knowing it.

The first mussels were found at Lake Mead Marina in 2007. This was a major setback for the 100th Meridian Initiative. The mussels found at Lake Mead Marina were sent to Robert McMahon at the University of Texas, Arlington, and he "…estimates that they have been in the lake for at least 2 years" (Stokstad p.453). To make matters worse, limnologists like Charles Ramcharan have stated, "The deep, cool water and rocky bottom offer an ideal habitat for the quagga mussels…Lake Mead is going to have a huge infestation" (Stokstad p.453).

Shortly after the Quagga mussels were found at Lake Mead, its close cousin, the Zebra mussel was also found within the lake at four other locations. Agencies since 2007 have turned their efforts to inspecting boats and watercraft leaving Lake Mead to make sure they do not contain either the Quagga mussel or Zebra mussels so they cannot infect other waterways. A main concern of the agencies is the fear that mussels may find their way to Hoover Dam, causing millions of dollars in damage and potential cleanup costs. They are also concerned the mussels will pass through the dam and migrate downstream to Lake Mohave and Lake Havasu.

It is hard to say what will happen to the ecosystem at Lake Mead now that the mussels are in fact in the lake. Studies completed regarding both the Zebra and Quagga mussels in Lake Mead estimate thousands, if not millions occupy the bottom of the lake (Andrew Muñoz 4/27/10). Since the mussels were only found three years ago, it is only time before they show up in the other reservoirs along the Colorado River. The next few years will reveal a lot regarding the mussels in the lake and how they affect the ecosystem within Lake Mead. U.S Fish and Game, The National Park Service, and other agencies have begun to conduct tests within Lake Mead to study the Quagga and Zebra mussels and its long-term effects (Stokstad p.453).

Water Consumption and the Southwest drought – Low Waters at Lake Mead

The Southwest is facing a crisis very few people know about or understand. The crisis is fairly young but slowly picking up momentum and could turn out to be a catastrophe if changes are not made. Lake Mead is currently releasing more water through the Hoover Dam than it is receiving from the Colorado River, a problem that is getting worse and worse now as summer 2010 is upon us. This crisis is fairly new, roughly ten years old. Starting in 1999-2000, the Southwest began what some predict to be a drought that could last upwards of multiple-decades (Mark). Droughts in the Southwest are fairly common and the last few years are no exception. Scientists have been using dendrochronology, or the study of tree rings, to examine droughts dating back to 762 AD in the Southwest (Mark). The findings are not reassuring for the Southwest but they do provide scientists and agencies a look into what the past couple of hundred years have been like in the region. Many variables come into play when explaining the

low water levels at Lake Mead, most trace back to the water rights that were setup in the 1920's.

Las Vegas is a very large city, smack dab in the middle of a desert valley. Up until the recent housing market collapse, Las Vegas was one of the most rapid growing cities in the United States. Las Vegas in the early 1950's contained roughly 25,000 people. With Hoover Dam in full operation and Lake Mead filling up, city planners in Las Vegas were hoping the population in 2000 would grow to around 100,000 people. The fact is, in 2000, Las Vegas contained roughly 1.9 million people (Walsh). The city planners of Las Vegas in the 1950's, "…they were off by a factor of 19" (Walsh). In other words, Las Vegas is 19 times bigger than it was envisioned to be. Lake Mead and Hoover Dam have had no real issues meeting the needs of roughly 1.9 million people in the Las Vegas Valley up until 2000. The amount of people moving to Las Vegas in the early 2000's were a couple thousand a month, and little did these people know that the weather patterns in the area were changing rapidly to a much drier climate

The Colorado River Compact comes up a lot when discussing current allocation numbers to each basin, but with great reason. The upper and lower basins were allocated seven and a half million acre-feet annually, with the lower basin able to take another million acre-feet when needed. That is sixteen million acre-feet annually. To put this into perspective, the USGS claims 3.07 acre-feet of water is one million gallons of water. Taking that number, each basin is allocated seven and a half million acre-feet of water so doing the conversion supplied by the USGS that is a substantial amount of water being allocated to each basin. Now imagine the Colorado River's flow being cut by 25%, or almost fourteen million gallons annually. That is exactly what is happening in the 21st

century. Part of the problem is that when surveyors in the 1920's calculated the flow of the Colorado River it was an extremely wet period for the region, roughly eighteen million acre-feet annually was passing down the river. Today it is only an average of 13.5 million acre-feet passing down the Colorado River annually (Mark). The following graph depicts the water level of the lake beginning in 1937 to present day. The graph shows that within the last ten years there has been a substantial decline in water levels resulting in inefficient water supply to surrounding cities.

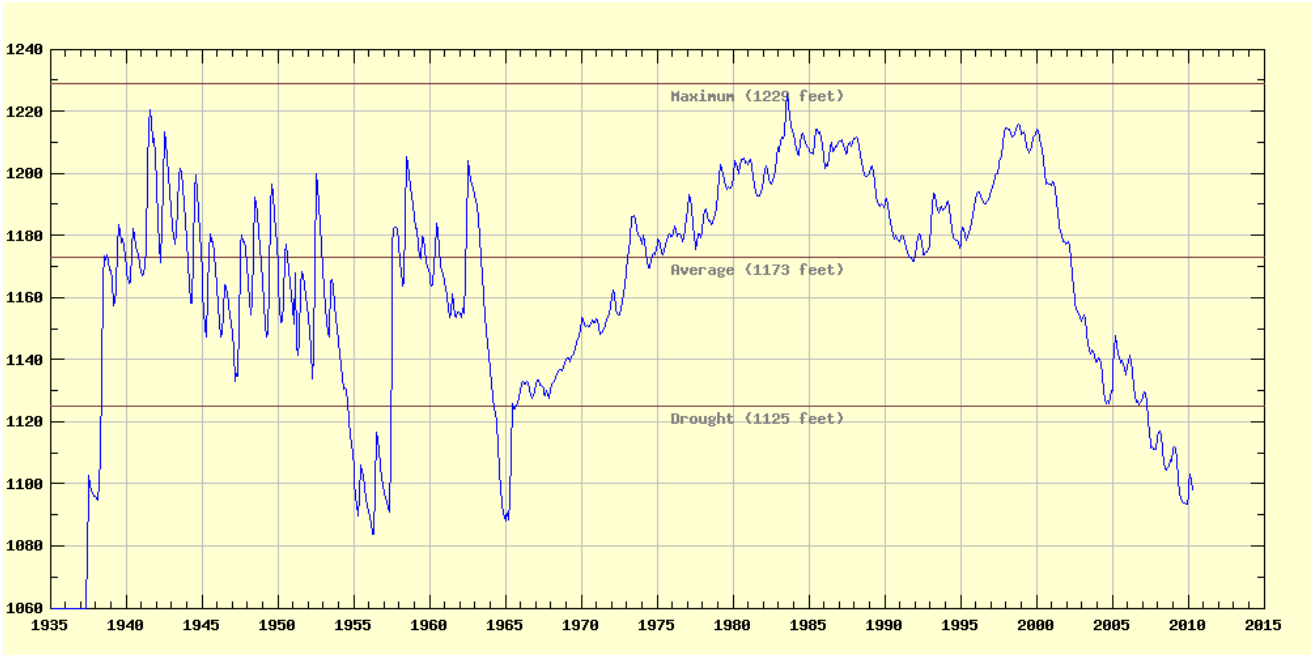

Figure 2: Courtesy of *Lake Mead Water Levels — Historical and Current* (http://www.arachnoid.com/NaturalResources/)

Since the lake began filling up in 1937, the lake has only been lower than today two other times in its lifetime. Once in 1955, but it only took one year for it to get back up to normal levels, and again in 1965 and 1966 when the Glen Canyon Dam became operational forcing the federal government to cut water to Lake Mead to fill up the new

Lake Powell. During that time (1965-1966) it took Lake Mead almost a decade to get back up to normal levels. So why not just reverse the Colorado River Compact and give every state less water? Much easier said than done. Water is gold to each state; every state needs water for their economies to prosper, and millions of people in each state rely on the water for their every day needs. The Colorado River water rights are extremely hard to change once they became legal in 1922. Many Supreme Court cases over the years have been fought over the Colorado River, mainly *Arizona v. California*. They all addressed allocation of water rights to their respective states. The most difficult problem with regards to the Colorado River is not the cities that use its water, rather "…about three quarters of the Lower Colorado River water goes to agriculture", mainly desert farmers (Mark). The Federal Government subsidizes most of the water supplied to these farmers. United States Department of the Interior Secretary Ken Salazar in recent months has said new policies regarding the allocation of the Colorado River will be discussed as water levels continue to decrease. For example, Secretary Salazar has already granted the Lake Mead National Recreation Area $16.7 million in economic recovery funds (National Park Service).

Lake Mead is in a very hot area of the United States. It is not uncommon for air temperatures to be in the 110+ degree Fahrenheit range during the summer months. The USGS during January 1998 and December 1999 conducted a series of tests to calculate the evaporation of water from the lake in a typical year. The findings were about 15% greater than previously predicted (Westenburg). The lake during the testing lost on average seven and a half feet of water annually (Westenburg). This is a large amount of water when the lake's surface area is roughly 247 square miles (Columbia). So on top of

the demands of farming, and the growing cities in the Southwest, Lake Mead is also losing water through Mother Nature.

It is hard to explain in writing how low the water level is at Lake Mead. As of May 2010, Lake Mead is 124 feet below full pool. The lake is predicted to drop another twenty feet between 2010 and 2011. In an interview with Andrew Muñoz, the Public Affairs Officer for the Lake Mead National Recreation Area (Lake Mead NRA), Muñoz stated that "for every twenty foot water level drop, the Lake Mead NRA spends about $6 million to extend launch ramps, grade roads, beaches and parking lots, move restrooms, extend utilities, etc." The repercussions of low water levels has led to the construction of new launch ramps being built at Echo Bay Marina and Callville Bay Marina at a cost of $3.2 million and $2.5 million respectively (Andrew Muñoz 4/27/10). These funds are above the $18 million the Lake Mead NRA receives from the Federal Government (Andrew Muñoz 4/27/10). He also went on to mention that the Lake Mead NRA pays for these projects via federal land sale money authorized under the Southern Nevada Public Land Management Act. With the recent decline in real estate sales, the Lake Mead NRA is trying to pass new legislation to increase the fees to enter the park to help pay for the funds needed to keep up with the dropping water.

To further complicate matters, the Southern Nevada Water Authority (SNWA) draws almost 100% of its water from Lake Mead through two intakes. One of the intakes is 60 feet below the current water levels while the other is 110 feet below. The SNWA is concerned that the shallower intake could suck air if the water level continues to drop, thus they have started a project to drill and install a new third level intake. Blasting

below Lake Mead began during May 2010. The project is estimated to cost roughly $800 million with a projected finish in 2013 (Milstein).

The low water level at Lake Mead has continued to get worse and very little government intervention has yet to take place. Without intervention by the Federal Government, Lake Mead runs the risk of needing federal funds in order to sustain agriculture and provide for the major cities it supplies. While the main cause of the low water levels at Lake Mead are due to the current droughts, political reasons also play a factor. As of now, the original Water Rights Compact of 1922 still stands resulting in problems among the states that share the lower basin. California does not want to stop farming in the desert in order to cut down on water usage because it is a huge part of the economy. Arizona does not want to cut back on its share of water usage because California purchases an ample amount of water from Arizona yearly; and finally Nevada cannot conserve 90% of its water (the same amount it gets from Lake Mead). The issues Lake Mead faces need to be brought to the public eye on a national level, so that everyone understands the crisis the Southwestern drought will have on millions of people. Failure to do so will be catastrophic to the Southwest and the nation as a whole. We have only begun to see the tip of the iceberg, and failure to start making changes will cripple the Southwest in the near future and possibly for many decades.

Chapter III – Benefits of Lake Mead

When looking at a typical United States History textbook, flip to the chapter on the Great Depression during the 1930's, and there is almost always a section dealing with the Hoover Dam. The construction of Hoover Dam is absolutely amazing and seeing it in

person helps convey what an engineering marvel it is. Seeing the dam in pictures or reading about it without seeing it with your own eyes does it no justice.

That brings me to the unsung hero of the Southwest, Lake Mead. Lake Mead is rarely talked about in United States History textbooks besides the fact Hoover Dam blocks the Colorado River to form Lake Mead. Lake Mead is in a present day crisis; very few out of the millions of people that use the lake every year realize this. The lake is a key player in providing the local and national economy with stability.

Oasis in the Desert – Lake Mead's Positive Economic Impact

Lake Mead's impact on the economy is vast. Nevada, Arizona, California, and a few other states benefit directly from the lake as stated previously. While the lake itself is large, 274 square miles with 550 miles of shoreline, the national recreation area surrounding it is even larger (Columbia). Andrew Muñoz was again able to provide key facts and figures regarding Lake Mead and the Lake Mead National Recreation Area (Lake Mead NRA). The National Park Service (NPS) and Bureau of Reclamation has controlled Lake Mead since it was formed in the late 1930's, but the name was changed to Lake Mead National Recreation Area in August of 1947. Then in 1964 the Lake Mead National Recreation Area was added officially to the National Park system making it the first and largest National Recreation Area in the United States. The Lake Mead National Recreation Area includes Lake Mead and Lake Mohave, which is located down river of Hoover Dam.

Andrew Muñoz provided documents showing the annual visits to the park from 1937 through 2009. In the 1937 calendar year, the Lake Mead Recreation Area had

552,128 visitors. In 2009, the park had 7,946,830, or just shy of eight million visitors. It is interesting to note the park had a 59.90% decline in 1942 over 1941 because in the 1941 to 1942 calendar year the United States entered World War II. In 1945, the park experienced a 122.91% increase in visitors over the previous year, and a 98.38% increase of visitors in 1946 over 1945. These would be the highest fluctuation of visitors in the park over the course of record keeping. The park has had little fluctuation in visitor numbers since 2000 despite the low water levels. The average fluctuation between 2000 and 2009 is a slight decline of 1.68% based on calculations I have done with the visitation document provided to me by Officer Muñoz.

The park in 2009 had just shy of eight million visitors. When compared to other National Parks in the United States, Lake Mead NRA is one of the most visited. The Lake Mead NRA has more visitors on average per year than Yosemite Nation Park (averages 3.6 million visitors annually) and the Grand Canyon National Park (averages 4.4 million visitors annually) combined. On a typical holiday weekend, the Lake Mead NRA averages 140,000 visitors which equals more than the annual visitors to 40% of the National Parks in the United States (Andrew Muñoz 4/27/10). With only one small hotel and a motel on Lake Mead, the visitors to the lake need somewhere to stay. Most stay at the Fiesta Hotel in Henderson or the Hacienda Hotel in Boulder City, thus providing these areas with a major boost in economic income during summer months. Neither hotel was able to provide information on the number of guests during the summer months although they did say it was a significant number. Officer Muñoz predicts the Lake Mead National Recreation Area provides roughly $500 million annually to the local economy. The concessions found within the Lake Mead NRA gross roughly $45 million annually.

The Lake Mead National Recreational Area is really its own little bubble. It contains: eight water and water waste systems, 340 buildings (seven of which are fire stations), 240 miles of paved roads, 850 miles of gravel or dirt roads, seven campgrounds with 955 sites, seven major marinas (five of which are located on Lake Mead [Las Vegas Boat Harbor, Lake Mead Marina, Callville Bay, Echo Bay, and Temple Bar]), and $1 billion in infrastructure. Each marina on Lake Mead varies in annual income. Lake Mead Marina pulls in $500,000, Callville Bay $600,000, Echo Bay $375,000, and Temple Bar $300,000. There is a cruise service on Lake Mead that takes tourists on an old paddlewheel boat to Hoover Dam from Lake Mead Marina and has an annual income of $120,000. The Lake Mead National Recreation Area provides employment to 220 people who help run the park.

To continue with the figures Officer Muñoz provided, the Lake Mead NRA is located where three of the four North American deserts come together. They include the Great Basin Desert, Mojave Desert, and Great Sonoran Desert. Within Lake Mead NRA, there are nine wilderness areas (roughly 185,000 acres), 900 plant species, 500 animal species, twenty-five threatened or endangered species, and 1.8 million years of geological occurrences. It is important to note the Lake Mead National Recreation Area is a preservation agency, thus you cannot remove anything from the park, disturb the habitat, go off-roading, etc. Many visitors to the park think taking a souvenir rock or other natural or cultural items is ok, but is in fact illegal.

Beyond the data provided by Officer Muñoz, Lake Mead provides Las Vegas, Lake Las Vegas, and surrounding areas with economic support that cannot be calculated, for example how many people stay in Las Vegas visit Lake Mead? Many visitors to

fabulous Las Vegas will spend a day at Lake Mead or Hoover Dam since it is one of the top travel destinations in the United States. Many Americans know about the history of Hoover Dam and want to experience it in person, taking tours of Hoover Dam via Hoover Dam Tour Company or tours of Lake Mead via Lake Mead Cruises. Many visitors to the area take helicopter tours of the Grand Canyon, Hoover Dam, and Lake Mead. It is impossible to calculate how much Lake Mead has provided the surrounding areas with economic stability, but the numbers are in the billions. If Lake Mead does go dry by 2021, the impact on not just the area but also the region would be devastating.

Final Words

Lake Mead is an important part of my life, having been visiting the lake for over fifteen years. I have a lot of great childhood memories visiting the lake, bonding with my family, and exploring new locations around Lake Mead. In that relatively short span, roughly 20% of the lakes lifetime I have seen the lake at its second highest point and now its second lowest point since the lake was formed in 1937. In the past fifteen years I have witnessed a lot of change around Lake Mead. The start, construction, and now almost completion of the Boulder Bridge Bypass, which runs south of Hoover Dam to help alleviate traffic going across Hoover Dam. The closing of marinas on Lake Mead due to low water levels, the relocation of Las Vegas Bay Marina and Lake Mead Marina. The history of Lake Mead is always changing but especially in the last decade.

I cannot stress enough that the policies in place by the federal, state, and local governments that use Lake Mead in their current state are broken and not working. Lake Mead is in a crisis, yet I feel government officials are more worried about their political

ego and the sense that the water in Lake Mead will always be there like it always has been since 1937. The dark reality is if policies are not changed, farming practices changed, and better education of the general public on water usage in the Southwest, Lake Mead will cease to exist. Many will argue the lake has been this low before and I cannot disagree, but the fact is, more people today rely on the lake than ever before. The threats and the benefits of Lake Mead I have outlined are both the realities we face today. To benefit from the lake and take all of its positive aspects, threats like water quality, mussels, and low water levels will come also. If the lake disappears in 2021 like many predict, we will have neither the positive nor negative aspects.

Lake Mead is a wonderful place and I hope to be able to share the vast area with my future family and grandchildren. Lake Mead has had a very positive impact on my life and helped shape who I am today.

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